Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Theory of Nuclear Matter for Neutron Stars and Supernovae

By

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I developed a Finite-Range Thomas Fermi (hereafter, FRTF) model for supernovae and neutron star matter based on the nuclear model of Seyler and Blanchard, and Myers and Swiatecki. The nuclear model has been extended to finite temperature and a Wigner-Seitz geometry. I also extended the model to include additional density dependent interactions to better fit known nuclear compressibilities.

Using my model, I evaluated nuclear surface properties using the semi-infinite interface. The coexistence curve of nuclear matter for two-phase equilibrium was calculated. Furthermore I have calculated energy, radii, and surface thickness of closed shell nuclei in which the spin-orbit interactions can be neglected.
To get an optimized parameter set for FRTF, I confirmed the allowed range of symmetry energy and the density derivative of symmetry energy. This confirms recent experimental results, astrophysical implications, and theoretical pure neutron matter calculations. The correlation between symmetry energy and the surface symmetry energy in liquid droplet model was also obtained. The beta equilibrium matter was used to model the neutron star crust.

I constructed a nuclear EOS table for hot dense matter for given density, proton fraction, and temperature. I used the liquid droplet approach to generate thermodynamically consistent nuclear EOS. Neutron skin on the surface of heavy nuclei is added for thermodynamic consistency and phase transition to nuclear pasta phase is considered using geometric shape function *D*. For comparison, I generated EOS table using SLy4 non-relativisitc Skyrme force model.
For both FRTF and SLy4, more than 10 % of EOS tables contain heavy nuclei, alpha particles, and nucleons.

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